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Fast Miles: A Multimodal Strategy Integrated with Credit-Based Congestion Pricing

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Abstract

In America's large and severely congested metropolitan areas, carpools and express bus service could attract many more riders if buses and carpools could operate between residential areas and job centers on free flowing highways that provide premium service opportunities. *FAST Miles* attempts to eliminate recurring congestion on limited-access highway systems using a possibly more publicly acceptable form of road pricing, along with an integrated multi-modal strategy to encourage shifts of solo-driving commuters to alternative modes. Every motorist would get a share of peak period use of *FAST* highway facilities "already paid for" through his or her taxes, through a limited number of free *FAST Miles* credits. *FAST Miles* could be self-financing and may even generate a surplus that could be used for expansion of transportation capacity. It could also introduce new possibilities for public-private partnerships for the efficient and effective provision of metropolitan transportation services, including expansion of transportation infrastructure and operation of the priced highway system, the express bus system, and passenger access and distribution services at transit transfer stations.

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Several metropolitan planning organizations have proposed networks of premium-service Bus/High-Occupancy Vehicle (HOV) lanes or High-Occupancy Toll (HOT) lanes to create free-flowing traffic conditions for buses and HOVs. However, funds available to invest in complete networks of such facilities are inadequate, due to high costs for highway facility expansion and special direct access ramps that are needed in order to safely provide access for buses. For example, a feasibility study for a network of HOT lanes in the Twin Cities of Minnesota suggests that tolls could pay for only 15 percent to 55 percent of the cost of building the lanes (Cambridge Systematics, Inc. 2005). In some cases, limited rights-of-way and environmental and community impacts preclude highway expansion altogether, leaving some segments where buses would need to run in mixed traffic on congested highways.

This paper presents a new credit-based congestion pricing concept called *FAST Miles* that seeks to create a complete premium-service express bus and HOV network without an immediate need for highway expansion, while at the same time providing new incentives for HOV and transit use through improved passenger access and distribution services at residential and employment ends of the commute trip. There has been recent interest among researchers in Texas with regard to the concept of credit-based congestion pricing (Burris et al 2005, Gulipalli and Kockelman 2005). However, these researchers have not integrated transit and HOV service improvements into their research and analysis, and may have presented the concept in a more complex fashion than it needs to be. This paper presents an approach to maximize the benefits of credit-based congestion pricing by integrating transit and HOV improvements into the concept. Also, it attempts to improve its public acceptability by simplifying it so that it parallels a pricing scheme used in the private sector that appears to be easy for the public to understand.

The *FAST Miles* Concept

One cellular phone plan offered in the U.S. (i.e., Verizon) allows an unlimited number of free calls during off-peak periods and weekends, but limits free minutes on weekdays during the peak daytime period. Customers pay per minute charges for calls above the free limit during peak periods. The phone company is able to eliminate daytime congestion. This reduces the need to add expensive new capacity to serve more discretionary calls during peak periods, and encourages people to make these calls during off-peak times.

This phone service charging concept may be transferable to public services subject to peak demands, such as transportation. *FAST Miles* is such a concept. It allocates to motorists a limited number of free miles for use in peak periods on limited-access highways. Every motorist would get a share of peak period use of *FAST* highway facilities "already paid for" through his or her taxes through free *FAST Miles* credits. Total outstanding credits are limited to the number of vehicle miles of available peak period capacity in order to ensure that the metropolitan highway system does not get congested. This ensures that express bus services operate faster, providing better levels of service at lower cost.

All metropolitan area motorists would be provided with an electronic transponder – a device that would capture miles driven on limited-access highways during the morning and afternoon peak periods. ATM-like machines now dispense transponders in sticker form for as little as $5 each in Puerto Rico. Out-of-towners could obtain transponders from such machines at visitor centers or through the mail. With a nationally coordinated *FAST Miles* program, “sticker” transponders could be made available to all motorists nationwide.

Each licensed motorist would get a personal *FAST Miles* account allowing a limited number of free peak period highway miles per day. Additional miles could be purchased at rates that would depend on congestion levels. Rates per mile would be set high enough to dissuade some discretionary trip-makers from peak period use. This would guarantee that demand does not exceed supply of congestion-free road space available, and would prevent the breakdown of the free flow of traffic. The extent of the highway system on which peak period highway mileage charges would apply would be determined based on the extent of congestion on the system.

Mileage charges would only apply to limited-access highways, and only on congested segments during peak periods. Charges would not be practical on surface arterials. In order to charge for use of surface arterials, transponder readers would be needed on every block to prevent motorists from evading charges by diverting to alternate streets at charging points, increasing implementation costs significantly. Therefore, all motorists could still drive for free on surface streets at any time of the day.

Congestion levels vary both by highway segment location and the specific time of travel within the peak period. Therefore, free miles would be charged to motorists’ accounts at a discounted rate during those times and on those segments that have less heavy demand. Conversely, free mile “surcharges” would be applied to more heavily used segments and at more heavily used times (i.e., motorists would need to use their free miles at a higher rate than actual miles driven.)

Those participating in carpools and vanpools could link their *FAST Miles* accounts. This would allow those who currently drive solo in single occupant vehicles (SOVs) and have long commute trips to avail of additional free miles by sharing the ride. Transit operators could attract commuters by providing a fare credit equal to the value of the commuter’s free *FAST* miles if the commuter links his or her *FAST Miles* and transit fare card accounts.

Motorists with unused free miles would get cash rebates equal to the value of the unused miles annually though their vehicle registration or vehicle property tax bills. Those who drive extra miles would provide the cash to pay for cash rebates for those who use less than their allotted share.

The *FAST Miles* concept would produce what has been termed a “Fast And Intertwined Regular” (FAIR) highway network - a metropolitan highway system with two classes of service: a *FAST* network of free-flowing limited-access highways allowing for efficient and effective operation of express bus services; and a *Regular* network of surface arterials (DeCorla-Souza 2005a).

Benefits from *FAST Miles*

With *FAST Miles*, the entire limited-access highway system would serve the purpose of a "fixed guideway" for transit. High occupancy vehicles would get premium service free of charge on *FAST* highways when those participating in a carpool link together their *FAST Miles* accounts. Therefore, the need for tax dollars to support public investment in special express bus and HOV lanes would be eliminated, including costs for additional pavement and rights-of-way for new special-purpose bus/HOV lanes, for lane separation, for special ramps to provide access to and egress from the lanes, and for enforcement of vehicle occupancy requirements for carpools.

Maximum vehicle flow on limited-access highways occurs when highway speeds are 55 to 65 mph. Vehicle throughput on a severely congested freeway may be reduced significantly due to the increase in vehicle density and the concomitant drop in speeds. When traffic volumes reach a certain threshold level - approximately 2,000 vehicles per lane per hour or a vehicle density of about 35 vehicles per lane per mile - traffic flow breaks down, and speed as well as vehicle throughput decrease precipitously. This has been termed "the freeway congestion paradox" (Chen and Varaiya 2002). Even though demand may decrease after the peak period, the highway does not recover its full vehicle throughput capacity until much later, because queued vehicles from previous hours keep vehicle density high and speeds sluggish. By ensuring that traffic flow does not break down in the first instance, *FAST Miles* may actually *increase* highway vehicle throughput in peak periods.

The variably tolled Express Lanes in the median of SR 91 in Orange County, CA demonstrate the ability of pricing to maximize highway throughput by keeping traffic at free flow speeds. Speeds are 60 to 65 mph on the priced Express Lanes. In the peak hour, they carry almost as many vehicles as do the congested free lanes even though there are twice as many free lanes (U.S. Department of Transportation 2004). Pricing of the Express Lanes allows twice as many vehicles to be served per lane in the peak hour at three to four times the speed on the free lanes. Almost half the public investment in free lanes is simply wasted in peak hours. *FAST Miles* can restore to full use the public investment that is being lost everyday on congested highways during critical times of the day when the investment is most needed.

A rough idea of the magnitude of benefits to motorists on *FAST* highways may be obtained by a few simple calculations. The analysis in Table 1 provides estimates of fuel costs saved by motorists for three levels of congestion: (1) extreme, with speeds averaging 15 mph; (2) severe, with speeds averaging 20 mph; and (3) moderate, with speeds averaging 30 mph. Based on the American Association of State Highway and Transportation Officials' Manual on *User Benefit Analysis for Highways* (ECONorthwest, Kittelson & Associates and Parsons Brickerhoff Quade and Douglas, Inc. 2003), excess fuel consumption per minute of delay, caused by accelerations and decelerations on a freeway designed for 65 mph speeds, amounts to 0.328 gallons for 2-axle single unit trucks, 0.447 gallons for 3-axle single unit trucks, and 0.578 gallons for combination vehicles. The Manual on *User Benefit Analysis for Highways* also reports that excess fuel consumption per minute of delay on a freeway designed for 65 mph speeds amounts to 0.042 gallons for small cars, 0.066 gallons for big cars, and 0.083 gallons for SUVs. Table 1 uses these estimates to calculate fuel cost savings when recurring congestion delay is eliminated with pricing.

Table 1. Transportation Cost Savings with Rush Hour Pricing

		Fuel saved (gal./min.)	Fuel cost savings ($/mile)	Value of Time ($/min.)	Time Savings ($/mile)	Total savings ($/mile)
Extreme Congestion						
Delay per mile (min.)	3.00					
Trucks						
2-axle single unit		0.328	**$2.46**	$0.30	$0.90	**$3.36**
3-axle single unit		0.447	**$3.35**	$0.30	$0.90	**$4.25**
Combination vehicle		0.578	**$4.34**	$0.30	$0.90	**$5.24**
Passenger Cars						
Small		0.042	**$0.32**	$0.17	$0.50	**$0.82**
Large		0.066	**$0.50**	$0.17	$0.50	**$1.00**
SUV		0.083	**$0.62**	$0.17	$0.50	**$1.12**
Severe Congestion						
Delay per mile (min.)	2.00					
Trucks						
2-axle single unit		0.328	**$1.64**	$0.30	$0.60	**$2.24**
3-axle single unit		0.447	**$2.24**	$0.30	$0.60	**$2.84**
Combination vehicle		0.578	**$2.89**	$0.30	$0.60	**$3.49**
Passenger Cars						
Small		0.042	**$0.21**	$0.17	$0.33	**$0.54**
Large		0.066	**$0.33**	$0.17	$0.33	**$0.66**
SUV		0.083	**$0.42**	$0.17	$0.33	**$0.75**
Moderate Congestion						
Delay per mile (min.)	1.00					
Trucks						
2-axle single unit		0.328	**$0.82**	$0.30	$0.30	**$1.12**
3-axle single unit		0.447	**$1.12**	$0.30	$0.30	**$1.42**
Combination vehicle		0.578	**$1.45**	$0.30	$0.30	**$1.75**
Passenger Cars						
Small		0.042	**$0.11**	$0.17	$0.17	**$0.27**
Large		0.066	**$0.17**	$0.17	$0.17	**$0.33**
SUV		0.083	**$0.21**	$0.17	$0.17	**$0.37**
Assumptions						
Fuel cost ($ per gallon)		$2.50				

Assuming an average value of time of $10.00 per person hour for passenger vehicles and $18.00 for trucks (U.S. Department of Transportation 2003), the value of vehicle travel time savings at the three levels of congestion varies from 16.5 cents to 50 cents per mile for passenger vehicles, assuming vehicle occupancy of 1.0, and from 30 cents to 90 cents for trucks. These additional non-monetary savings may be added to the net monetary savings from the reduction in fuel consumption.

A large metropolitan area with about 4 million people, such as Washington, DC, generates about 10 million passenger car VMT and about 1 million truck VMT in the peak periods daily on its limited access highway system. Assuming moderate levels of congestion currently, these highway trips would save at least $1.12 per truck VMT and at least $0.27 per passenger car VMT, based on estimates in Table 1. Thus, pricing to eliminate recurring congestion would result in savings of at least $1.12 million per day for trucks and $2.7 million per day for passenger cars, totaling about $3.82 million daily or almost $1 billion over 250 working weekdays each year.

Eliminating recurring congestion would also have benefits for express bus riders, and the reliability of both transit and highway trip times would increase significantly. The value of travel time reliability has been estimated at 100 percent to 250 percent of the value of travel time savings (Brownstone and Small 2002, HLB Decision Economics and University of California at Irvine 2001). Accidents and related costs would also be reduced. Thus, if benefits to transit riders, and additional benefits to motorists in the form of accident savings and travel time reliability improvements are accounted for, total benefits to travelers on the *FAST* network would exceed by far the benefits estimated above based on motorist travel time savings alone.

Travelers who change their travel behavior in response to implementation of *FAST Miles* may suffer some disbenefits. Those travelers that respond by changing their travel route may also cause additional delays to other motorists on those routes. The key to ensuring that these disbenefits are minimized is to ensure that levels of service on alternative modes (mainly transit and HOV) are enhanced as much as possible so that the aggregate “disutility” of cost, travel time and inconvenience of these modes (including access and egress) is lower than the aggregate disutility of cost, travel time and inconvenience of driving alone on alternative free (but congested) highways.

Also, negative impacts from traffic diversion can be minimized through use of surplus *FAST Miles* revenue for investments in advanced arterial signal systems. This will help accommodate traffic diversions, if any. Due to increased vehicle throughput on free-flowing freeways, however, diversions from arterials to the freeway may in some cases exceed any diversions from the freeway to arterials. As discussed earlier, empirical evidence from SR 91 suggests that the higher throughput on the two priced lanes (per direction) allows more traffic to be carried through the corridor than would have been possible if all six lanes (per direction) were free.

As base levels of congestion get worse in future, it will be easier for transit and HOV options to provide better levels of service to commuters than solo driving in congested conditions. As travel demand increases, extra mile charge rates will also rise, providing more *FAIR Miles* revenue – and making appropriate investments in transit and HOV services, including access and egress to transfer locations, more financially feasible.

By reducing vehicular travel, *FAST Miles* would lead to lower automobile pollutant emissions and improve metropolitan air quality. Urban sprawl may be discouraged if people choose to live closer to their jobs in order to reduce *FAST Miles* charges, rather than choosing to live far from urban centers in order to take advantage of free highways and lower housing prices, as many do now. On the other hand, the choice to live further away from dense urban centers may become more appealing to some as a result of the provision of new express bus services and ancillary access and egress improvements, new opportunities to form carpools, an increase in *FAST* highway vehicle throughput due to elimination of high levels of recurring congestion, and improved levels of highway service due to elimination of traffic flow breakdowns. Creation of new transportation capacity, whether through new transit and HOV investments or through elimination of inefficiencies on the existing highway system, has the potential to induce new development farther away from city centers.

To reduce this effect, it will be important to forewarn those considering buying homes far from urban centers that *FAST Miles* charges for extra miles may increase in future, especially if new transportation capacity does not keep pace with growth in peak period vehicular travel demand. This is exactly the situation currently being experienced with regard to toll rates on the SR 91 Express Lanes in Orange County. The facility serves commuters from the rapidly growing suburban community of Riverside County, and maximum toll rates for the 10-mile segment have increased from about $2.50 ten years ago to almost $8.00 today due to rapid growth in travel demand in the corridor.

Public Acceptance

How will the public react to adjustable *FAST Miles* charges? The public appears to have little confidence in the effectiveness of adjustable tolling as a traffic reduction strategy. A *Washington Post-ABC News* poll (Langer 2005) found that only 7 percent of people believe that such tolling is very effective as a traffic remedy. However, carpooling and transit are believed to be very effective by 39 percent and 42 percent of people respectively.

Since *FAST Miles* is an integrated multi-modal strategy that would include significant incentives for carpooling and transit, the public may have greater confidence in the effectiveness of *FAST Miles.* While only 29 percent of people support adjustable tolls, 51 percent support HOV lanes (Langer 2005). With *FAST Miles*, the entire highway system would, in effect, be transformed into an HOV system that provides premium service for high occupancy vehicles, express buses and paratransit services. Therefore, the *FAST Miles* concept may get a higher level of support from the public than adjustable mileage charges by themselves would.

However, people may still oppose the “new” charges, especially those who currently drive alone for long distances. Their concerns may be alleviated somewhat by guaranteeing that no charges will be made to their *FAST Miles* accounts for any miles for which they did not get congestion-free service. To demonstrate that their total commute costs will actually be reduced, data such as that presented in Table 1 will need to be convincingly presented to them.

Some may be concerned about the new ability of the government to monitor their vehicle movements. These public concerns may be alleviated if a private operator is hired to run the system and the government does not control the data, similar to credit card companies. Additionally, the private operator could be required to discard all data daily at the end of the afternoon peak period, saving only the gross amount of money charges incurred by each account holder on that day. Motorists may request that their daily usage data be forwarded to them electronically at the end of each day before being erased from the system, if they would like to check for accuracy of charges.

Will the public perceive *FAST Miles* as equitable? Other road pricing schemes that have been accepted by the public tend to require motorists to bear new charges if they want to avail of premium highway service. Consequently, premium-service facilities such as the SR 91 Express Lanes in Orange County, California have disproportionately higher use by high-income motorists (U.S. Department of Transportation 2004). On the other hand, with *FAST Miles*, motorists would be allocated an equal number of free miles regardless of income level. Low-income motorists, who tend to drive fewer miles, could cash in on their unused miles. This could further improve the public’s perceptions about the equity of *Fast Miles*.

With *FAST Miles*, those who have long highway commute trips and choose to continue to drive solo would, through charges for extra miles, help pay for highway or transit capacity expansion, or for carpool park-and-ride facilities. Shifts in mode of travel encouraged by these improvements would free up existing highway capacity to accommodate the remaining vehicle trips more efficiently. The rest of the public would not have to pay for disproportionately higher demands placed on the highway system in peak periods by trip makers with longer commutes -- either through congestion delays imposed upon them, as under the existing system; or through new taxes or tolls that are often proposed to pay for new capacity in order to relieve that congestion.

Opposition to new charges based on the perception of “double taxation” would be weakened. Every motorist would get a share of peak period use of *FAST* highway facilities “already paid for” through his or her taxes. Those who would like to avail of greater use would have a choice to do so by paying for it.

Won’t commuters with longer trips simply divert to free roadways and cause additional congestion on them, infuriating local residents? Research by Washbrook (2002) and Shoup (1994) suggests that, while improvements in travel time for carpools and transit by themselves do not generally achieve a high level of mode shift, these improvements can be *extremely* effective when combined with an increase in charges for road use or parking. When new highway charges are combined with carpooling and transit improvements, vehicular demand will be reduced significantly due to increased use of alternative modes. Traffic may actually be *reduced* on parallel arterials as some arterial travelers who were previously deterred by freeway congestion shift back to free-flowing highways whose vehicle throughput has increased (as discussed earlier).

Public-Private Partnership Possibilities

A new model for partnerships with the private sector could be used to implement and operate *FAST Miles* and supporting transit and carpool systems. Private highway system operators could be paid by public agencies based on the number of vehicle miles of travel provided congestion-free service, using "shadow tolls." This is termed the Concurrent Real And Shadow Tolling (CRAST) model (DeCorla-Souza 2005b). Operators would have an incentive to ensure that the entire pricing scheme is set up to maximize vehicle throughput on the highway system at free-flow speeds. All revenues from extra mileage charges would go to public agencies. Thus, private operators would have no incentive to keep extra mile rates higher than they need to be for the purpose of managing demand, and would instead have an incentive to keep rates as low as possible to maximize use without degrading levels of service. Potential private operators could be selected based on open competition. Criteria for selection could include the lowest fee per free-flowing vehicle mile they would be willing to accept as compensation for their services.

To encourage private provision of new transit services, private operators of transit services could be made eligible for subsidies based on *FAST Mile* credits turned in by their patrons. For example, assuming a market value of 15 cents per credit mile, if a patron were to turn in four free miles per day from his or her *FAST Miles* account, the transit operator could be eligible for a doubling of the public payment for the four unused free miles, or a total of $1.20. Private entrepreneurs would thus have incentives to establish targeted paratransit or vanpool services to cater to the needs of commuters.

Similarly, private provision of services for access and egress to transit stations and for park-and-ride facilities may be encouraged by allowing the use of *FAST Miles* credits as payment for service, with reimbursements for the credits provided by the public sector at a higher rate per unused credit mile. Private businesses can operate bike rental services, shuttle bus services and shared-ride taxi services at transit transfer locations.

High extra mile toll rates on specific freeway segments would suggest the urgent need for capacity enhancements, while at the same time providing some of the funding needed. Based on observed extra mile rates and corridor traffic forecasts, freeway segments could be prioritized by the public agency for capacity enhancements. Private proposals could then be solicited to address capacity expansion needs. Private partners could be selected for the most urgent corridor expansion projects including, potentially, capacity on alternative modes or freeways on new alignments designed to shift development away from existing congested freeways, if existing corridors cannot be expanded.

The CRAST model could be used as the basis for infrastructure expansion contracts. An enhancement of the CRAST model may be possible as a result of research currently underway in San Diego, CA (Federal Highway Administration 2004) with regard to technology to count vehicle occupants for the purpose of enforcing HOV lane restrictions. Photographic systems employing near infra-red cameras have achieved some success in counting vehicle occupants, and have been shown to have some potential for further improvement and deployment (University of Minnesota Department of Computer Science 1999). The key to ensuring that the private sector will seek to maximize public goals is to use appropriate measures of performance and have appropriate payment schemes that provide the right incentives to private partners. As technology for counting vehicle occupants improves, contracts could be designed under which the private partner could be paid on the basis of the number of *person* trips (rather than vehicle trips) carried on the freeway facility during peak periods, monitored using advanced technologies such as near infra-red camera technology to count vehicle occupants. For example, if a vehicle has four occupants, the private partner would be paid four times the shadow toll per person.

With shadow toll payments based on *person* throughput rather than vehicle throughput, private partners would have an incentive to design proposals that encourage greater *person* throughput during rush hours, such as by promoting transit and ridesharing modes. They might work with other private and public partners to provide appropriate collection and distribution services for express bus transit and vanpool trips, or to market new travel options to the commuting public. The winning bidder could be selected based on consideration of the amount of new "person trip" capacity that would be provided, its adequacy to serve forecasted travel demand, and degree of financial self-sufficiency of the multimodal proposal. This approach would maximize the flexibility of private bidders to come up with the most innovative, cost-effective and financially viable proposals, with modal investment choices made based on economic efficiency. This would minimize public and social costs for transportation and maximize financial self-sufficiency.

Highway users paying tolls would get a greater return on investment of surplus toll revenue if there is flexibility to spend toll revenue on those improvements that reduce congestion delay most cost-effectively. For example, "new" road capacity becomes available to a motorist in peak periods each time another driver is diverted away from solo driving and into a passenger mode in a carpool or a transit vehicle. In some cases, it can be less expensive and more cost-efficient to provide financial support for peak period ridesharing and transit service than to provide new highway lanes for solo-drivers.

Phasing In *FAST Miles*

It is important that enhanced transit and carpool systems be in place before the *FAST Miles* credit/charging program goes into operation. Introducing monetary prices for rush hour use of highways by itself will have a very limited impact if travel options are not already available and well understood by the traveling public. This may present a "chicken and egg" problem with regard to funding, since transit and carpool investments will need to be made and services will need to be established before revenues from *FAST*

Miles operation begin to kick in. Thus, it will be important to secure in advance the public funding needed. A possible source might be the issuance of bonds backed by the future stream of revenues after *FAST Miles* implementation.

A more difficult problem will be that the critical time advantages needed for success of transit and vanpool services are difficult to provide before free-flowing traffic conditions are created by *FAST Miles*. Creative ways to develop travel time advantages for transit and vanpools may be needed. One potential solution is establishing an extra "rush hour lane" for use by buses and authorized vanpools by re-striping the highway to allow shoulder use during rush hours. This strategy has been implemented in the Washington, DC metropolitan area for buses on the Dulles Connector, and for buses and HOVs on I-66 outside the Capital Beltway. Restricting use of the shoulder lane to authorized vehicles ensures that safety will not be compromised.

With Bus/vanpool lanes and express bus services in place in advance of *FAST Miles* implementation, commuters will have an opportunity to understand and experience some of the travel time advantages that a full-fledged *FAST Miles* system might provide after the entire highway is free-flowing. To increase public understanding of the new and enhanced systems, it will be important to implement complementary travel demand management programs, such as:

(1) *Free transit trial periods* as in Seattle, WA;
(2) *Web-based pre-trip planning programs* as in the Netherlands, that allow commuters to compare the door-to-door travel times and costs of alternative modal combinations, as well as alternative start times for their commute trips;
(3) *Individualized marketing programs* such as in Lund, Sweden, where commuters are visited in their homes or at their job sites by transportation advisors who discuss the various travel options available to them.

Financial Self-Sufficiency

Would region-wide implementation of *FAST Miles* be financially self-sufficient? Could sufficient surpluses be generated to provide support for new transit and HOV services needed to make rush hour pricing successful? In an attempt to evaluate its potential, this section presents a region-wide analysis of potential costs and revenues from implementation of a multimodal *FAST Miles* strategy in the Washington, DC metropolitan area.

In 2003, the average daily congested travel period in major U.S. metropolitan areas amounted to about six and one-half hours, and the share of daily travel subjected to congested roadway conditions amounted to about 40 percent (Texas Transportation Institute 2005). The Washington, DC metropolitan area is even more congested. However, for this analysis, only 33 percent of daily freeway travel was assumed to occur in congested conditions in a 6-hour peak period that would warrant the use of pricing to manage demand. These lower estimates were used to ensure a conservative estimate of tolled traffic and therefore revenue.

Table 1 provides estimates of vehicle miles of travel (VMT) that would be subjected to tolls in the morning and afternoon peak periods, based on the following:

- Total current daily freeway vehicle miles of travel (VMT) amounts to 37.8 million (Texas Transportation Institute 2005).
- Thirty-three percent of daily freeway travel is currently congested.
- Ten percent of peak period VMT is truck VMT.
- Peak period freeway VMT would need to be reduced by 10 percent on congested segments.

While the needed reduction in VMT appears to be low, it should be noted that the *Highway Capacity Manual* (Transportation Research Board 2000) indicates that a freeway remains free flowing and uncongested until about 90 percent of its maximum possible traffic volume is achieved. Thus, currently congested freeways need a reduction of just 10 percent of their traffic volumes for free-flowing traffic to be restored. Drivers in the Washington, DC metropolitan area notice this phenomenon in August every year when peak period traffic is reduced by only small amounts due to some commuters being on vacation. Californians observe it on days when only state government employees are off work due to a state holiday (Wachs 2003). In such situations, there is not sufficient time for "equilibrium" with regard to traffic congestion to be restored, i.e., people who previously changed their mode, route, or time of travel choice due to congestion do not immediately get back on the highways during the peak periods to take advantage of the reduced congestion.

With other forms of travel demand management that might theoretically reduce traffic by 10 percent, such as prohibiting trucks from use of freeways during peak periods, a large portion of the traffic returns and re-congests the freeway. This is due to the phenomenon of "triple convergence," i.e., demand attracted to the freeway from other routes, other modes and other times of the day due to improved freeway travel times (Downs 1990). Unlike other demand management strategies, pricing keeps induced traffic from materializing by increasing the monetary cost to the motorist at the same time that travel time "cost" is reduced.

In a large metropolitan area, such as Washington, DC with about 4 million people, two-thirds of residents are licensed drivers. Thus total available peak period passenger car capacity will need to be allocated among about 2.7 million drivers. If the 10.1 million passenger car miles that can be carried on the limited-access highway system in peak periods (see Table 1) are allocated among 2.7 million drivers, each driver would be allocated a peak period VMT share of 3.7 miles per day, or 18.5 miles per week.

<u>Extra Mile Toll Rates</u>

Average peak charges per extra mile to ensure free-flowing traffic conditions on the currently congested limited-access highway are conservatively estimated at about 20 cents for passenger cars, based on the following rationale:

- Average peak period tolls on the SR 91 express lanes amount to about 40 cents per mile, based on the current toll schedule (Orange County Transportation

Authority 2005). Tolls are charged on only four out of 12 lanes (i.e., two out of six in each direction). If all 12 lanes of SR 91 were to be tolled in peak periods at levels to assure free flow of traffic (as are the four express lanes), supply of "express" lanes would increase threefold. Average peak period tolls per mile for passenger cars would likely be reduced to about one-half of the current toll rate, or about 20 cents per mile. This is based on the assumption that the minimum value of time of newly tolled SR 91 drivers would be at least half of the minimum value of time revealed by willingness-to-pay of those using the four express lanes currently. Given typical observed distributions of values of time of motorists (Steimetz and Brownstone 2004), it is reasonable to assume that 10 percent of all current SR 91 motorists would be "tolled off" by a toll applied to all lanes that is 50 percent of the current toll on the express lanes.

- Since SR 91 is a relatively more severely congested facility, the average peak period toll per mile for an "average" congested facility may be somewhat lower. On the other hand, the 3.7 free miles allowed per driver per day would have the effect of reducing the number of miles that will be tolled on a one-way commute trip by about 1.8 miles (i.e., half the daily allocation), thereby increasing willingness-to-pay for the balance of freeway commute miles. Therefore, it is estimated that the average toll rate for extra miles will be 20 cents per mile.

The average freeway length used by a motorist who uses the freeway during peak periods is estimated at 5 miles, calculated as follows:

- Forty-two percent of VMT in large metro areas is carried on limited-access highways (DeCorla-Souza and Fleet 1990);
- Average vehicle trip length is 11.84 miles (U.S. Department of Transportation 2004);
- Therefore, VMT on limited access highways = 0.42 X 11.84 = 5 miles.

Since 1.8 miles of travel would be free, the balance of 3.2 miles (i.e., 64 percent of travel) would be tolled. Since a heavy truck on average consumes two to three times the lane capacity of an automobile in free-flowing traffic, tolls for trucks would need to be about 2 to 3 times the toll for passenger cars, or about 50 cents per mile. All truck VMT would be tolled, since trucks would not be eligible for free miles. However, as Table 1 suggests, total monetary costs for trucks would still be lower than without pricing, because fuel cost savings per mile would exceed truck tolls per mile. Fuel cost savings range from $0.82 to $1.45 per mile for moderately congested conditions, and are much higher at higher levels of congestion.

The term "average" toll as used in this illustration bears explanation. Since peaking may be directional, let us assume we are considering a downtown-oriented freeway on which the peak period lasts a total of 6 hours in each direction. In the outbound direction, the peak lasts just one hour in the morning, while it lasts 5 hours in the evening. Thus, in the outbound direction, extra mile charges may be:

- 10 cents (or 0.5 free miles) per mile in the single AM peak hour;
- 30 cents (or 1.5 free miles) per mile in the peak hour of the PM peak period

- 20 cents (or 1.0 free miles) per mile in the two hours surrounding the PM peak hour
- 10 cents per mile (or 0.5 free miles) in the next two shoulder hours of the PM peak period

Table 2. Revenue from Region-wide Pricing (2005 $)

<u>Region-wide daily highway VMT ('000):</u>	
Total daily freeway VMT (from FHWA's Highway Statistics)	37,815
Percent of freeway VMT that is subjected to congestion	33.00%
Daily freeway VMT subjected to congestion	12,479
Estimated percent VMT reduction due to pricing	10%
Estimated freeway VMT that will be tolled	11,231
Percent VMT by trucks in peak periods on freeways	10%
Tolled VMT by trucks in peak periods on freeways	1,123
VMT by passenger vehicles on freeways	10,108
Share of peak period passenger car VMT that is tolled	64%
Tolled passenger car VMT in peak periods on freeways	6,469
Free passenger car VMT in peak periods on freeways	3,639
<u>Estimate of Toll Revenue</u>	
Estimate of toll rate per mile for trucks	$0.50
Estimate of toll rate per mile for passenger cars	$0.20
Daily toll revenue from trucks ($000)	$562
Daily toll revenue from passenger cars ($000)	$1,294
Daily toll revenue total ($000)	$1,855
Number of days tolling is in effect	250
Annual toll revenue (million $)	**$464**
Rebate rate for unused free miles (as a % of toll value)	75%
Rebate rate for unused free miles	$0.15
Annual rebated cash (million $)	$136
Annual net revenue (million $)	**$327**

Table 3. Annualized Costs and Revenue (2005 $)

<u>Costs</u>	
Annualized capital costs for toll collection/traffic mgmt (million $)	$7
Operations cost for toll collection/traffic mgmt (million $)	$90
Highway cost subtotal (million $)	**$97**
Express bus service cost (million $)	$159
Cost of parking for transit and HOV passengers (million $)	$40
Transit/HOV cost subtotal (million $)	**$200**
Highway/transit/HOV cost total (million $)	**$297**
<u>Revenue</u>	
Net revenue after refunding value of unused miles ($M)	**$327**
Transit fare revenue (million $)	$47
Highway/transit/HOV net revenue total (million $)	**$374**

Financial Self-Sufficiency

Revenue from tolled traffic shown in Table 2 is estimated by multiplying traffic that would be subjected to tolls by the respective average toll rates for passenger vehicles and trucks. Annual revenues were estimated by assuming the pricing schemes would operate on 250 working weekdays each year. Note that all estimates are in real 2005 dollars.

Table 3 presents cost estimates in real 2005 dollars. Procedures used to estimate annualized costs are discussed by the author elsewhere (DeCorla-Souza 2005b). These costs include capital and operating costs for region-wide highway network tolling and traffic management, for express bus service, and for park-and-ride facilities.

Transit fares are assumed to be $1.00 per trip, and free parking is assumed at park-and-ride lots. A comparison of net toll and fare revenue to multimodal costs in Table 3 suggests that annual revenue will be adequate to pay for annualized costs for highway, transit and HOV services and there will be significant surpluses. This suggests that self-financing public-private partnership arrangements may be feasible. The CRAST model may be used to develop agreements with private partners. Partners could be sought for contracts to operate larger parts of the regional network, e.g., the Virginia, Maryland and District of Columbia sub-networks in the Washington, DC metropolitan area. Private partners could also operate the transit and park-and-ride facility components using public-private partnership arrangements under which private providers are compensated based on usage rather than the quantity of service provided, providing incentives for private partners to market and promote transit and HOV modes (DeCorla-Souza 2005c).

Surpluses may be used to fund infrastructure expansion in high travel demand corridors. Alternatively, it may be cost-efficient to use surpluses to fund new investments in highway or transit services off the freeway system to benefit freeway corridor users, such as: (a) traffic management and improvements on parallel arterials, which could reduce freeway demand, and therefore the going toll rates; (b) improvements to arterials used for access to the freeway system; or (c) improvements to ways of accessing express bus stations, such as improved shuttle, carsharing or taxi-sharing services, or improvements to pedestrian and bicycle facilities. This would help keep rush hour toll rates low, by making transit more attractive and therefore reducing the demand for freeway driving.

Some or all of the surpluses could alternatively be refunded to motorists in the form of rebates on fixed auto-related charges such as vehicle registration fees, vehicle property taxes or drivers' license fees. This could reduce "double taxation" concerns, i.e., the public perception that tolls are a second tax for use of the same facility.

Concluding Thoughts

FAST Miles attempts to use free market principles on highway systems to encourage transit and HOV use and eliminate recurring highway congestion. It could introduce new possibilities for public-private partnerships for the efficient and effective provision of transportation services, including highway and bus operations, and passenger collection and distribution services.

FAST Miles packages credit-based congestion pricing with incentives for transit and carpool use, which have higher levels of public support than road pricing by itself. *FAST Miles* would provide an equal amount of premium service free of charge to motorists of *all* income levels, and impose new charges for use of existing highways on only those who choose to use highways far more than others during peak times when road space is scarce. However, concerted efforts will need to be made to involve the public in the detailed development of the concept in order to alleviate public concerns. *FAST Miles* and its benefits are complex and difficult to explain in a sound byte.

Metropolitan Planning Organizations may be best positioned to conduct the type of extensive public involvement needed to alleviate the public's concerns, and to develop more detailed concepts with public participation. Implementing *FAST Miles* will be no easy task. The highly successful congestion charging scheme established in central London in 2003 is smaller in scale than a region-wide application of *FAST Miles* would be. Yet it took many years of preparation, bold political leadership, and a favorable institutional setting to establish the central London scheme.

A pilot demonstration of the concept may be needed to convince the public of its merits. It is suggested that, as with the seven-month congestion pricing trial set to begin in Stockholm in January 2006, State or Federal funding support could be provided to encourage one metropolitan area in the U.S. to institute a one-year trial of the concept. The funding would provide support for the new Rush Hour Lanes for transit, for capital and operating costs for toll collection and traffic management, and for new transit services.

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